AMSAT SATELLITE REPORT

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The First Science OSCAR

Imagine for a moment that you could look at the ionosphere in such a way that you could readily know its condition in your vicinity. Further, imagine a small group of stations just like yours networked for the purpose of producing sophisticated ionospheric maps which would allow insight to fortuitous propagation paths. Now stop imagining and come to understand that these capabilities may be close at hand with the impending launch of Amateur Radio's first purely scientific satellite: UoSAT.

In a little more than a month, the UoSAT amateur scientific satellite will be launched from Vandenberg AFB California aboard a Delta rocket. The Delta will also carry another scientific package called Solar Mesopheric Explorer. UoSAT will, in the words of its program director, G3YJO, begin to redress the imbalance between the operational and technical interests manifested in recent years.

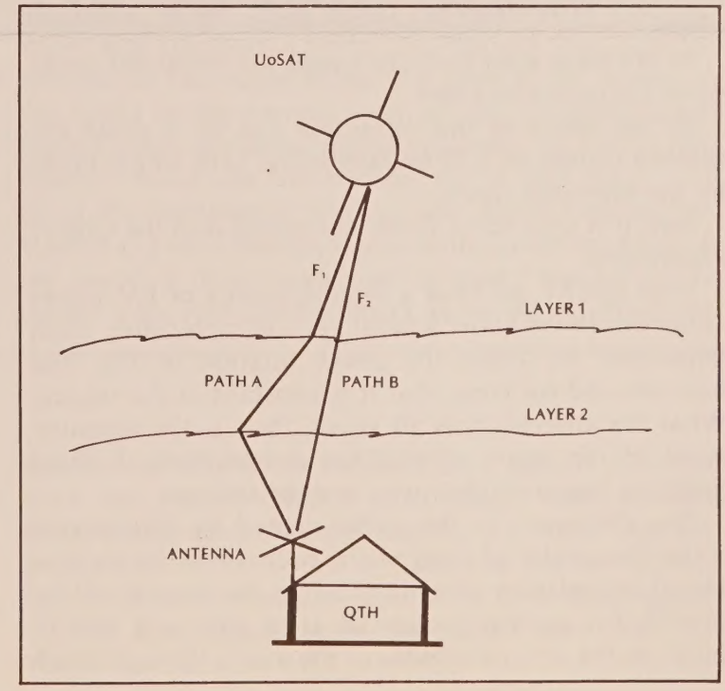
Of what is UoSAT capable? How can you participate and use the future AMSAT-OSCAR 9? Beginning with this issue of *ASR* we will look at some of the interesting features of UoSAT. Because of space limitations, our view will be necessarily brief. Details and technical solutions must await in-depth articles pursuant to that of Martin Sweeting's fine introduction in *ORBIT* #6.

In this *ASR* Tech Brief we will look at the phase coherent beacon experiment of UoSAT. When we're through, you should know what it is, how it works and what its significance is. A future *ORBIT* will explain how *you* can build and use compatible equipment to directly participate.

As is generally well-known among Radio Amateurs, the region of the atmosphere from about 50 to 250 miles in altitude is of great interest since it is within this region that reflection of hf radio waves generally occurs. Prior to radio satellites, the only way in which signals could be sent well beyond the optical horizon was by virtue of ionospheric reflection and EME, i.e. using the moon as a passive reflector. It is therefore of paramount interest to hf amateur communicators to have current status reports about the condition of the ionosphere. Several methods are available for this purpose. However, the character of the methods and the accuracy resulting varies considerably. At one end of the scale are published long-range forecasts based on predicted solar activity with an assumed linkage to ionospheric condition. At mid-scale are daily forecasts by government agencies and research institutes which produce reports such as the Solar-Terrestrial indices transmitted by the National Bureau of Standards station, WWV, on 2.5, 5, 10, 15 and 20 MHz at 18 minutes past each hour. At the other end of the scale are real-time measurements that you yourself make by probing the hf bands passively (by listening to and noting the areas from which signals are originating) and actively (by calling CQ to see who/where responses come from).

With UoSAT, a new and powerful *active* probe will be added to the amateur arsenal. Here's how it works.

There are four hf transmitters (among others) aboard UoSAT. The outputs of the transmitters are on 40, 20, 15 and 10 meters and radiate a power of a couple hundred milliwatts each. Nevertheless, given a reasonably competent station, anyone who tries will likely hear these beacons. What is special about the beacons, besides the QRP levels of these hf beacons, is the relation of the phase of the output signal of each: it remains constant or phase-locked. This is crucial to the experiment as shall become evident shortly. Phase coherence is another way of expressing the concept of phase-locking. Thus each



wave of the phase coherent beacons leaves the antenna with the same phase relation to the waves of the other beacons. They all depart the UoSAT in step with each other. What has happened to the phase relationship when the waves get to your antennas is what makes this probe interesting. First, though, we need to know a little physics.

Though electro-magnetic (EM) radiation such as light and radio waves travel at 186,289 miles per second in a vacuum, these waves are slowed by traveling in denser media such as air, glass, to name a few common dielectrics. In fact the velocity of an EM wave depends on certain properties of the dielectric. The familiar rainbow emanating from a glass prism set in the sunlight demonstrates vividly the effect. The higher frequencies (blue light) are not refracted as much as the other colors. The red colors are substantially more refracted because of their lower frequency.

Much the same phenomenon occurs with radio waves. Thus, when we say that radio waves are "bounced" off the F2 layer or E layer, we are really saying that the collective effect on our signals of passing through layers of the ionosphere with varying propagation velocities is to refract the waves. In fact, a common result of the difference of the refractive index with varying frequency is the length of the so-called "skip-zone." Signals of 21 MHz will generally have a longer one-hop distance than will signals at 14 MHz. (with some exceptions under unusual circumstances.) So radio waves are also dispersed under certain conditions just as are light waves passing through a prism.

One very prominent effect of radio waves passing through the various layers of the ionosphere is that their phases become jumbled. That is to say that often, because of the different paths taken by the waves arriving at your antenna, the phase of the wave can vary widely. The phenomenon of QSB is one result when signals from various paths constructively and then destructively cointerfere.

To this point we have seen two important physical phenomenona that relate to the refraction and phase of waves.

A) We have seen that EM waves are refracted under some circumstances and

B) The effect of this refraction can be a phase difference caused by a difference in the path length taken by the divergent waves.

Now it is time to tie these two points into the UoSAT experiment!

With UoSAT we have a remote source of EM waves about which we know several key characteristics. Most important, we know the phase relation of the four beacons and we know that it is constant at the source. What the experiment is all about, then, is the measurement of the phase *after* it has passed through these jumbling layers on their way to your antenna.

The difference in the paths caused by the varying refraction angles of each of the four waves means that the phase relation which existed at the source will be modified in such a manner so as to give us a tool to measure the refractive index of the media through which the waves have passed. That's a rather complex way of saying we launch some waves at "A" and watch what happens to them when they arrive at "B"! And by knowing key properties such as the refractive index or electron density of the plasma along the path between you and the satellite, you can determine the state of the ionosphere; kind of like taking its temperature by remote control! And this information can lead to a map of the ionosphere.

But why four beacons, you might ask? Wouldn't two be sufficient? The two other beacons are there to remove any phase ambiguity that might arise from our inability to discriminate between the successive troughs, for example, of a particular wave.

The equipment needed to generate a simple plot of position versus electron density is well within the grasp of many who read *ASR*, though definitely not "off-the-shelf". Obviously one must be able to receive on 40, 20, 15 and 10 meters. So receivers and antennas for each band are necessary. The receivers, moreover, are special in several regards. The incoming signals are "beat" against each other in such a way that the resultant heterodyne contains the phase information we seek. Though not particularly complicated, the receivers are obviously fairly special. It is also reasonable to expect a construction article and perhaps even a kit of parts to appear in the usual places in the next year. On the other hand, the antennas can be quite elementary. Here one certainly would want to utilize wire antennas which favor higher angle radiation and are less sensitive to QRN and QRM such as ignition noise. Thus you should avoid vertical antennas. They would be your last choice here. More useful would be a series of horizontal loops for 40, 20, 15 and 10 nested perhaps.

In the shack the phase information must be fed to a computer for processing. The computer will take the phase information from the receivers and, by taking into account such variables as path length, doppler shift and spacecraft velocity (among others) will generate a value for the integrated electron density along the path between you and UoSAT at the instant the measurement was made. If the computer also has access to UoSAT tracking information and a CRT display, with suitable software you might be able to map a region in space "over your house" very nearly in realtime.

At maturity, we might see several stations participating in this experiment by networking via Phase IIIB and inputting observed data to a central point for processing and redistribution. A little further down the line we can envision the time when by listening to a certain satellite frequency and having the proper computer equipment at your disposal, you could obtain a map of the ionosphere showing where the openings were and maybe even provide insight to such transient phenomenon as trans-equatorial, E_s, as well as yet-to-be discovered modes.

UoSAT certainly has a host of interesting experiments aboard. This Tech Brief has addressed but one of the dozen or so that will be accessible to Amateurs around the world interested in pursuing Amateur Radio's technical branch.

ASR *Spotlight On: Martha Saragovitz*

Every organization has several focii; points where important lines of organizational structure converge. Situated squarely at the hub of AMSAT for nearly three years has been a native Washingtonian (D.C.) whom we all have come to call simply, "Martha."

Since September 1978 Martha has tended to the diverse needs of members and officers alike with dedication and enthusiasm. One suspects, however, that there were some trying moments at the outset. "You mean you actually build satellites? Ho, ho, ho." This, she must have thought is *really* a strange sort of bunch! But, being a liberal kind of school teacher, she decided to give AMSAT a try.

Thus began the relation which continues today. Since that time Martha's appreciation for what we do has increased together with her responsibilities. Today she is Office Manager as well as Corporate Secretary (an Officer of the Corporation).

Who *is* "Martha?"

Martha is a professional woman in her thirties with a huge social conscience. After graduating from American University in Washington, D.C. she became a school teacher in the Head Start Program which was a program to help specially needy children. We think Martha sees herself as a cultured individual. Her avocational interests reflect a broad spectrum. For example, she's travelled widely, is an avid landscape photographer and collects art. Her tastes in the latter center on oriental water colors and silk screen works as well as some lithography. She also collects porcelain. In this connection Martha often may be found at craft fairs in search of a "special" bargain in procelain.

When at home in the "Greenwich Village" section of D.C., Martha often relaxes to music such as that by Linda Ronstadt or occasionally some 60's rock & roll. Far from being a stuffy snob, as one might often visualize a so-called culture-seeker, Martha is a very sociable person. And not at all above rolling up her sleeves. For example, early in her AMSAT career she worked part-time on weekends doing CATV installations! Yes, that's right. The coveralls; the long drill and the spool of RG-59 under her arm coming out to your house!

Since that time she has taken on a number of special, and substantially more interesting assignments for AMSAT. Like the time she was an envoy to AMSAT UK while visiting England.

We often remind Martha that our colleagues in Newington encourage all employees to become licensed amateurs. Although we hadn't levied this "requirement" on Martha as a condition of her employment, it is apparent that she may have picked up the "bug" anyway. We understand she is learning the code, if sureptitiously. We think it's supposed to be a secret so don't let on that you know! When asked about her interests in Amateur Radio and satellites in particular, she just kind of grins. She admits that when Phase IIIA went in the ocean, as she stood in the control room at the Goddard Space Flight Center, she knew that the sadness she felt at that moment meant she was hooked! We're glad she is. And all of the members of AMSAT who *directly* depend on Martha and her continued conscientious efforts are glad she decided three years ago to give "this bunch of kooks" a try. *ASR* salutes this YL as one FB satellite folk!

Project OSCAR Meeting

Project OSCAR will hold the next in its series of general meetings on Saturday, 29 Aug. 81 at 1300 local time. The "usual" place in the L.A. vicinity is where you'll find the assembly this time as well. That is: The Officer's Club, Space Division, Los Angeles Air Force Station, El Segundo, California. W6SP is again your host and you should contact him for further information. All are welcome to attend. This should be a special occasion since the Project OSCAR folks expect some special guests will be attending the meeting. It is hoped that the UoSAT crew who will be in California for the UoSAT launch some two weeks later, will be attending the meeting. So stop by and get the UoSAT story from the " 'orses mouth!"

UoSAT Launch Still Go for 15 Sep

With the launch window opening at 0941 UTC, 15 Sep. 81, the amateur world awaits the next OSCAR. At press time all systems were go and the spacecraft was undergoing last minute alignment and check-outs. The beacon frequencies have been announced as: 7050, 14002, 21002 and 29510 kHz and 145.825 MHz.

UoSAT will be carried aloft aboard a Delta 2310 launch vehicle to a sun-synchronous circular orbit 336 miles (540 km) above the Earth's surface.

The AMSAT Launch Information Network/Service (ALINS) will be covering the UoSAT launch with a three or four station network similar to that which provided world-wide coverage for Ariane LO3 June 19. Times and frequencies for the ALINS will be announced on the AMSAT hf nets and here in *ASR* #14.

Revised AO-8 Ref. Orbits

Tuesday, 11 Aug, orbit 17500, 01:13:24 (HMS) at 81.1°
Tuesday, 18 Aug, orbit 17597, 00:02:39 at 63.6°

Voyager II Encounter This Month

A reminder that JPL station W6VIO will begin its famous SSTV and other activities later this week (Aug. 15). The TCA of Saturn will be 25 Aug. 81. Check *ASR* #9 for W6VIO operating times and frequencies for this very special operation. Shown below is the mission profile.

ASR Hablo Espangol!

The recent visit to AMSAT's spacecraft laboratory of AMSAT-Mexico President, Dave Lieberman, XE1TU, has begun to show results. Dave announces that he has translated *ASR* #11 to Spanish for amateurs who wish to read AMSAT's biweekly in their native language. Dave's effort is designed to increase the awareness of Central and South Americans in particular of progress in the world of amateur radio satellites. If you would like to obtain Spanish language editions of *ASR*, please contact Dave directly or write to *ASR* at our Editorial Offices.

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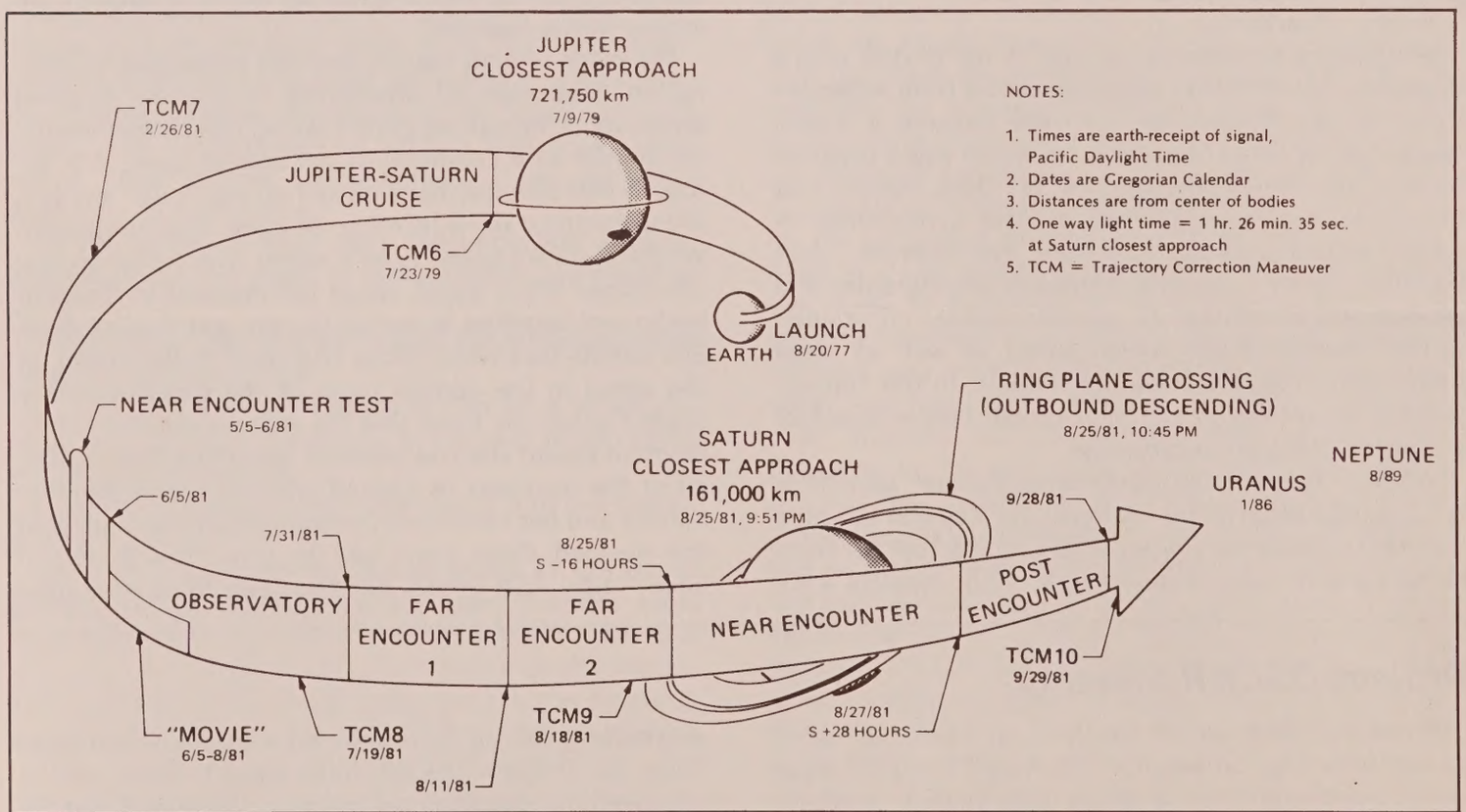
In addition, Dave has been discussing the merits of a Spanish language AMSAT net on the hf bands. Again the objective is to spark interest in Latin America in the amateur space program. If you have any ideas on the net, you may contact Dave or your Editor at the respective addresses above.

(Drawing courtesy of *Voyager Bulletin*)



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